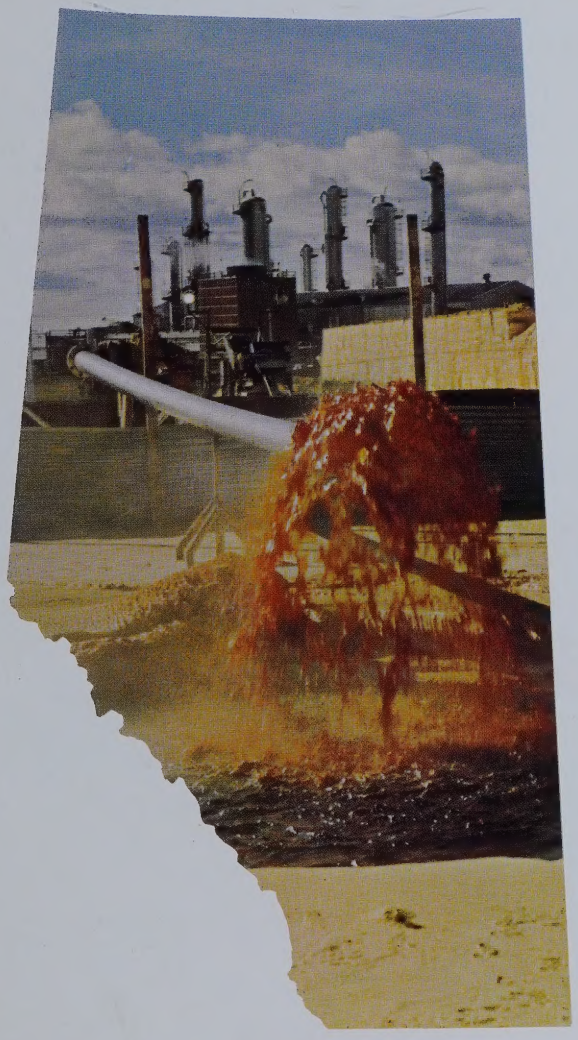
CONSERVATION IN ALBERTA

1970



ENERGY RESOURCES CONSERVATION BOARD
603 SIXTH AVENUE SOUTH WEST - CALGARY 1, ALBERTA

PREFACE

"Conservation in Alberta, 1970" has been prepared by the Oil and Gas Conservation Board to acquaint members of the Legislative Assembly of Alberta and the public at large with the conservation of Alberta's oil and gas resources and with the role of the Board. The text has been written in a non-technical style without detailed statistics.

At the 1971 Spring Session of the Provincial Legislature, the responsibilities of the Oil and Gas Conservation Board were extended to include similar responsibilities for coal and hydro electric; this increase in responsibilities resulted in a change of name to the Energy Resources Conservation Board.

The report includes a section on the Board's program for technical proficiency, an outline of the responsibilities of the Board, and a brief review of the reserves and production of oil and gas and their by-products. The enhanced recovery of crude oil and the conservation of solution gas are also discussed. This edition includes two special sections, the first describing the evolution and present relevance of Alberta's gas export policy, and the second dealing with the new pollution control measures adopted by the Board in 1970. The final section in the report briefly summarizes Board operations during 1970.

The more detailed publication "Report of the Operations of the Oil and Gas Conservation Board" will also be published for general distribution this year.

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COVER PICTURE: Our cover picture is a photograph of a typical sulphur pouring operation at an Alberta gas processing plant. It is reproduced courtesy of Great Plains Development Company of Canada, Ltd.

PUBLISHED BY ENERGY RESOURCES CONSERVATION BOARD
603 - 6 AVENUE SOUTH WEST, CALGARY 1, ALBERTA, CANADA

TECHNICAL PROFICIENCY

It is generally accepted that technology and scientific advancement have progressed more quickly during the 1950's and 1960's than in any previous 20-year period in history; there is every indication that such a pace will continue into and beyond the 1970's. For example, the Science Council of Canada stated that a Scientist beginning work in 1969 will find that 80 to 90 percent of all scientific achievements accomplished before the end of his career will have taken place during his working years. In these circumstances technically oriented organizations are finding that, in order to be successful, they must place special emphasis on the continuing education and training of their technical, professional, and support staff. It has been estimated that a university graduate must spend about 10 per cent of his working time expanding and reviewing his skills in order to maintain a relatively constant level of proficiency. Failure by an organization to place sufficient emphasis upon continuing education by its staff will lead not only to its inability to participate fully in industrial advances, but will also lead to obsolescence of the skills of its employees and threats to its progress and its very existence. The need for ensuring a continuing high degree of technical competence, as well as the need for developing innovative approaches, exists for government and its agencies as well as for private industry.

Oil and gas are non-renewable resources wherein today's waste is tomorrow's loss – a loss which is not likely to be recovered. Oil and gas production, field processing, and transportation of oil and gas today involve specialized knowledge. This knowledge is especially required to ensure maximum economic recovery with minimum disturbance to the environment. Consequently, the petroleum industry has developed a highly technical orientation involving considerable research so that it may avoid undue waste and increase the recoverability of oil and gas reserves. The hydro and electric industry has also been operating in a highly specialized environment where particular emphasis has been placed on technical advancement. The coal industry is becoming increasingly involved in the prevention of waste and in the safe and economic recoverability of coal reserves.

The Energy Resources Conservation Board is involved on a day-to-day basis with these energy industries where technological progress is rapid. Successful communication, realistic advice, appropriate regulations, and logical decisions can be achieved by the Board only if the level of technical competence of its own staff is comparable to that of industry. Many of the Board's responsibilities require the evaluation of relatively specialized matters or unique approaches in the fields of Engineering and Geology; special skills are also required in the areas of Data Processing, Economics, Accounting and Office Systems. Because of the high degree of competence required and also because the Board believes it has a responsibility to industry and to the public to remain abreast of new approaches and innovative techniques, a formal Technical Proficiency Program was adopted by the Oil and Gas Conservation Board in 1967. The Program is being continued by the new Board and will be extended to cover the Board's new areas of responsibility related to hydro and electric energy, coal and pipe lines.

There are a number of interrelated objectives of the Board's Technical Proficiency Program. A basic objective is the maintenance of the employee's general academic and technical qualifications at no less a level than he possessed when employed. For a university graduate this means maintaining his general technical capability at a level at least equivalent to that of current graduates. A second objective is the development and improvement of the particular skills which are continually applied by employees in their day-to-day work. For example, for staff concerned with oil and gas, emphasis is currently being placed on such topics as fluid coning to permit determination of critical production rates, recovery and reserve calculation procedures, pollution control, gas processing, and on special techniques such as mathematical simulation of reservoirs. Staff concerned with coal will place emphasis on reserve estimation, economic recovery, prevention of waste, and environmental control. Training in such topics is primarily intended to provide the employee with increased skills whereby he can increase his

work productivity; a benefit also accrues more personally to the employee in the form of increased job satisfaction and opportunities for advancement. A further objective of the Program is to permit the employee to retain familiarity in areas of specialized technical capability which he only infrequently encounters.

The Technical Proficiency Program is available to all Engineers and Geologists and other Professional staff. In addition, Technicians with more than one year Board service and other senior technical and support staff are also encouraged to participate. The Board's efforts toward continuing a high level of technical proficiency begin with the recruitment of university graduates and other technical personnel of high potential and proven academic ability. All eligible employees are encouraged to participate in the Program by spending ten per cent of their time at work in the study of subjects of interest to them and of value to the Board. It is expected that participating employees will invest a similar amount of personal time pursuing such studies. An approved study program may involve the undertaking of special projects, or it may involve university or similar courses on either a short course or semester basis. A number of Board staff are working toward advanced university degrees by attending approved courses both during and after normal working hours. Attendance at in-house seminars and courses is also considered as part of the ten per cent time allocation. In-house presentations are made by both Board staff and specialists drawn from the academic world or from private companies. The oil and gas industry has been most co-operative in assisting in the Program by supplying specialist lecturers and, in some instances, sharing its own staff training with selected Board personnel, apparently believing, as does the Board, that a well trained and fully informed Board staff will result in better administration of Alberta's conservation regulations. A small technical library which has borrowing arrangements with other local technical libraries is maintained in the Board's Calgary office.

The Board recognizes the value of membership and active participation in technical societies and professional associations, and encourages staff involvement. The Board pays one-half the membership fee in up to three job-related technical organizations, and also pays the costs incurred in attending meetings of such organizations. The Board views attendance at certain technical conferences by appropriate staff as important in keeping pace with technological advancement in the industry. Therefore, the full costs of attending such conferences both within Alberta and outside the Province and Canada is borne by the Board.

Because the Board supports and encourages the continued advancement of overall technical competence in job-related areas, employees who have developed some specialized knowledge in a topic of interest or value to industry are encouraged to prepare papers for publication. To date, the involvement of the staff in this activity has been somewhat below expectations, but further emphasis on this aspect of the overall Technical Proficiency Program is planned for the future.

It is evident that some of the proficiency required by the Board's staff can be obtained only at a post-graduate university level. As a result, an Educational Leave Plan has been incorporated into the Technical Proficiency Program. The Educational Leave Plan provides selected staff members with the opportunity of obtaining a post-graduate degree related to their Board employment while continuing to receive a portion of their normal salary during full-time attendance at a university.

Considerable investment has been made in the Program, in the form of work time used for on-the-job study and in direct costs. In 1970, total expenses were $200,000, which represents an equivalent of 12 per cent of the total salary costs of employees eligible to participate in the Technical Proficiency Program. Of this amount, over three-quarters was the cost of salaries paid while employees were engaged in on-the-job study; the remaining expenses were incurred for conferences, in-house and off-premises courses, professional association memberships, and dinner and executive meetings.

Although results of plans such as the Technical Proficiency Program are difficult to

assess quantitatively, there is little doubt that these efforts pay dividends in the long run to the participating employees and to the Board. The informal plan which existed before 1967 and the formal Technical Proficiency Program which was adopted in 1967 have continually been reviewed, improved, and emphasized. The Board recognizes that, particularly for voluntary programs such as this, certain aspects may not always produce the objectives desired. However, the Board feels satisfactory results have been shown to date, and even better results can be obtained in the future as a result of further modifications.

RESPONSIBILITIES OF THE BOARD

The Oil and Gas Conservation Board was established by the Alberta Legislature in 1938. In administering the provisions of The Oil and Gas Conservation Act, 1969, its objectives are the conservation of the Province's resources in oil, gas and the oil sands and the prevention of their waste, the ensuring of safe and efficient field practices, the affording of an opportunity for each owner of oil and gas in a pool to recover his share in its production and the recording and dissemination of information regarding the Province's resources in oil, gas and oil sands. The 1970 amendment to the Act gave the Board additional responsibilities in the control of pollution above, at or below the surface in oil and gas field operations and other operations over which the Board has jurisdiction.

To discharge its responsibilities effectively, the Board must see that in the light of sound engineering and economic principles, oil and gas field operations are so conducted that wells are properly located, spaced, drilled, equipped and produced, and the recovery of oil or gas from a pool is not lessened and reservoir energy is not improperly dissipated. The Board must also make certain that enhanced recovery techniques are used where suitable and that waste of gas is minimized.

In carrying out these functions the Board, in co-operation with industry, has established specific regulations and policies. The Act provides the Board with authority to require operators to undertake operations necessary to improve conservation. The Board, through its staff, maintains a close surveillance of each producing oil and gas field to ensure that producing operations will provide optimum recovery.

The Board has similar duties under the Act with regard to oil sands. It is also guided in this area by the Government policy of providing for the orderly development of the oil sands in a manner that will supplement but not displace production from the conventional oil industry.

Protection of the interests of owners in oil and gas pools is provided under the Act and Regulations. This is achieved largely by well spacing regulations and by the regulation of production under uniform rules. In exceptional cases further measures, such as common carrier or common purchaser orders, are available.

The Board co-operates with other Government departments and industry to ensure that oil field producing practices do not lead to excessive pollution or the destruction or contamination of other natural resources.

The Board is also responsible under The Gas Resources Preservation Act, 1956, for seeing to the effective utilization of the Province's gas resources. Applications for removal of gas or propane from Alberta are evaluated having regard to the present and future needs of the people within the Province, and permits are granted only for quantities surplus to these needs.

Since 1958, some special responsibilities in the old Turner Valley Field have been given to the Board by The Turner Valley Unit Operations Act. Because of the wide diversity of ownership in the Field, and to expedite plans for improving recovery from it, the Board was authorized to combine diverse holdings into a single unit operation if one or more owners requested it. Five units comprising the whole of the Turner Valley Rundle Pool have since been established.

PRODUCTION AND RESERVES

CRUDE OIL

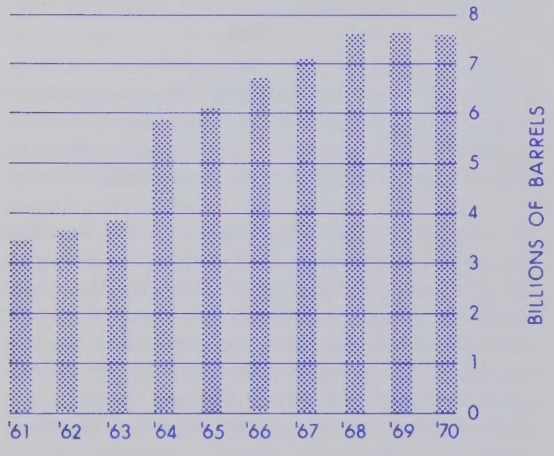
Alberta's conventional crude oil production averaged 892 thousand barrels per day in 1970, while daily production of synthetic crude oil from the Athabasca oil sands averaged 33 thousand barrels per day. Production of both types of crude oil was up some 17 per cent from 1969 production levels.

Canadian markets absorbed somewhat less than half of Alberta's crude oil production in 1970. Within Canada, Ontario consumption accounted for approximately 200 thousand barrels per day in 1970 as compared to about 170 thousand barrels per day in 1969. Alberta's crude oil demand totalled an estimated 91 thousand barrels per day in 1970, essentially the same level as in 1969. Alberta shipments to British Columbia, Saskatchewan and Manitoba increased slightly, totalling some 128 thousand barrels per day for an increase of some 5 thousand barrels per day over the 1969 level.

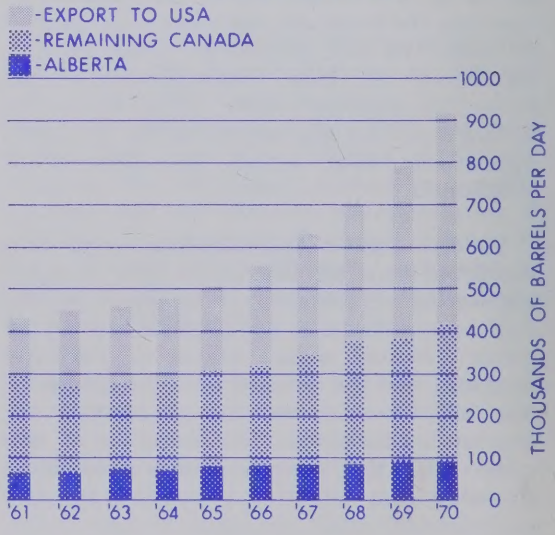
The volume of Alberta's crude oil exports to the United States increased 22 per cent over 1969 to average some 500 thousand barrels per day in 1970. Exports to markets east of the Rockies totalled some 310 thousand barrels per day during 1970, an increase of some 80 thousand barrels per day over the 1969 average. Alberta crude oil shipments to areas on the West Coast increased some 10 thousand barrels per day over the previous year to total about 190 thousand barrels per day.

In 1970 important changes were made in the United States regulations concerning the importation of Canadian oil into States east of the Rockies. Prior to March of 1970, imports of Canadian oil were limited by informal arrangements between the Canadian and United States Governments. Effective March 1, 1970, the United States Oil Import Policy was changed: a formal quota of 395 thousand barrels per day was imposed on imports of refinery feedstock from Canada, which had averaged 548 thousand barrels per day in January and February, and companies importing such feedstock were required to obtain licences. Amendments to the Policy after March had the effect of raising the volume of Canadian imports permitted to enter the region east of the Rockies. Thus, for the year as a whole, Canadian imports into this region substantially exceeded the quota levels set in March.

ALBERTA REMAINING CRUDE OIL RESERVES



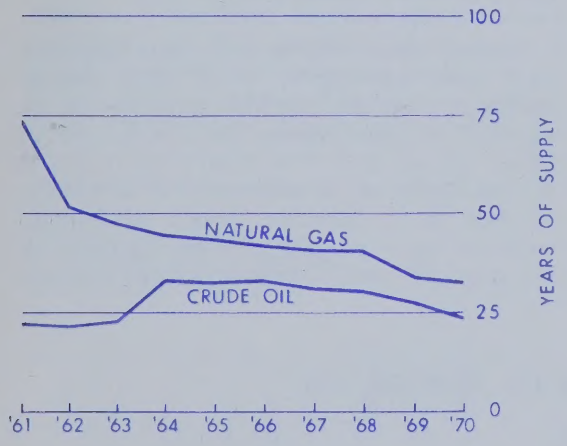
ALBERTA CRUDE OIL DELIVERIES



In December of 1970, Western Canadian oil producers obtained their first overall crude oil price increase in over eight years. Prices rose about 25 cents per barrel, bringing the average well head price for Alberta oils to $2.85 per barrel. The Canadian price increase followed increases announced in the major producing areas of the world, including the United States.

The year 1970 marked the first time since 1958 that additions to recoverable reserves were less than annual production levels. Production in 1970 totalled 326 million barrels, in comparison with only 232 million barrels in reserve additions. The remaining recoverable reserves of Alberta conventional crude oil at year-end 1970 totalled 7.6 million barrels, the equivalent to approximately 23 years of supply at 1970 production levels. This index of supply for Alberta conventional crude oil has now reached its lowest point since 1963 when the index stood at about 22 years. The historical trend in this index of supply of crude oil and of natural gas is shown in the accompanying chart.

YEARS OF SUPPLY OF ALBERTA CRUDE OIL AND NATURAL GAS



GAS

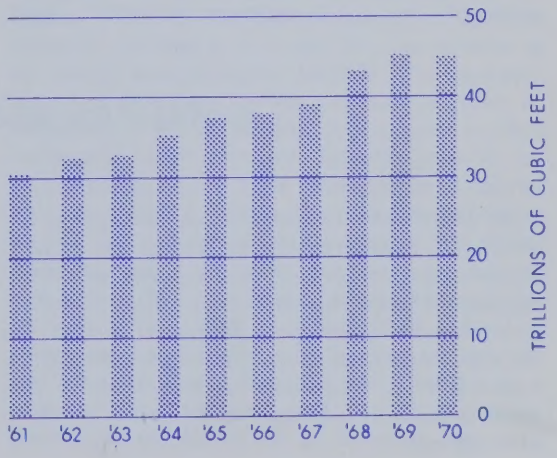
Production of marketable gas reached 1.4 trillion cubic feet in 1970, an increase of some 17 per cent over the previous year. Marketable production figures show the amount of gas available after allowances have been made for gas losses, shrinkage and fuel usage during production and processing operations, as well as volumes which are re-injected into producing reservoirs to maintain reservoir pressure. The amount of marketable gas made available amounted to approximately 70 per cent of the gross production for the year.

Deliveries of Alberta natural gas have been characterized by a prolonged period of remarkable growth. Canadian sales in 1970 totalled some 2.2 billion cubic feet per day, as compared to 1.9 billion cubic feet in 1969. Exports to the United States totalled some 1.7 billion cubic feet per day in 1970, an increase of 0.4 billion cubic feet per day over 1969 levels. The growth in gas sales is shown graphically in a following section of the report.

In July, 1970, the Board held the first of a series of hearings to determine Alberta's long term natural gas requirements. The requirements determined at these hearings form part of the basis for the Board's decisions regarding approval of applications to remove gas from the Province. It was concluded from the first hearing that Alberta's gas requirements would total some 15.8 trillion cubic feet over the 30-year period 1970 to 1999, with yearly requirements expected to double from 305 billion cubic feet in 1970 to 647 billion cubic feet in 1999.

Alberta's reserves of initial marketable gas were estimated to be 56.5 trillion cubic feet at year-end 1970, an increase of some 1.6 trillion cubic feet over the previous year. The increase was almost entirely due to reassessment and development drilling. New gas discoveries accounted for only 0.3 trillion cubic feet.

ALBERTA REMAINING NATURAL GAS RESERVES



Alberta's remaining marketable gas reserves at year-end 1970 were sufficient to sustain production at the 1970 rate for a period of some 32 years. Despite the fact that Alberta's reserve life index has exhibited a continual decline over the last decade, it remains high in relation to the United States, where gas reserves are equivalent to approximately 8 years of supply.

NATURAL GAS LIQUIDS

The term natural gas liquids embraces three products – pentanes plus, propane and butanes – which are produced in association with crude oil and natural gas. Production of these products expanded rapidly in 1970, as it has continued to do since 1961.

Pentanes plus is a product with properties similar to those of light crude oil. During 1970, daily production of pentanes plus averaged some 117 thousand barrels, an increase of about 15 per cent over the previous year, supplying approximately 13 per cent of the total demand for Alberta light and medium conventional crude oil. The plant gate price of pentanes plus increased about 15 cents per barrel in December of 1970, 10 cents less than the average crude oil price increase. The Board estimated 1970 remaining recoverable reserves of pentanes at 1.1 billion barrels, the equivalent of 27 years supply at 1970 production rates.

Propane production averaged 55 thousand barrels per day in 1970, an increase of almost 20 per cent from the previous year. Deliveries to Canadian consumers represented some 44 per cent of the total propane marketed, with shipments to the United States and offshore markets being 40 per cent and 16 per cent, respectively. Propane prices at the plant gate advanced slightly in 1970, averaging approximately $1.32 per barrel. Remaining reserves were estimated at 649 million barrels at year-end 1970.

Daily production of butanes averaged 34 thousand barrels in 1970, an increase of some 17 per cent over 1969. Exports to the United States provided the largest outlet, representing some 70 per cent of total deliveries of Alberta butanes. The average plant gate price per barrel declined slightly from 1969 levels.

SULPHUR

Essentially all of Canada's sulphur production originates in Alberta, where it is a by-product associated with the processing of sour gas. Alberta production increased some 14 per cent over 1969 to total 4.2 million long tons. Despite a rise of 20 per cent in deliveries over 1969 levels, some 1.1 million long tons of sulphur were added to inventory in 1970. Exports of Alberta sulphur production accounted for some 80 per cent of deliveries made in 1970.

Sulphur prices received by Alberta producers have fallen significantly. Since 1968, average plant gate prices declined from about $34.00 per long ton to approximately $9.00, a decrease of almost 73 per cent. This sharp price decline is further reflected in revenues received from sulphur sales. Over the period 1969-1970, revenue from sulphur decreased from $59 million to $27 million, a decrease of 54 per cent.

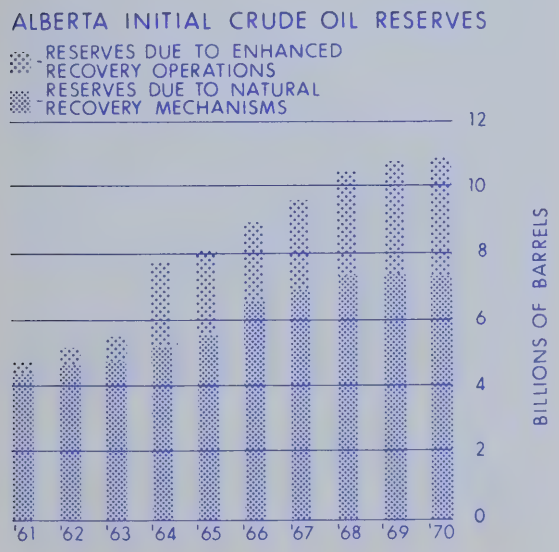
ENHANCED RECOVERY OF CRUDE OIL

As crude oil consumption increases, the oil and gas industry endeavours to ensure continuity of supply by finding new crude oil reservoirs and also by applying artificial recovery improvement techniques in place of natural recovery mechanisms as a means of increasing recovery from developed crude oil pools. The latter procedure is known as enhanced recovery of crude oil.

One of the primary objectives of the Board organization is promoting the use of efficient enhanced recovery operations in crude oil pools in the Province wherever such operations are economically feasible. An intimate knowledge of the nature and expected performance of a crude oil pool under its natural recovery mechanism is prerequisite to evaluating the need for and suitability of applying enhanced recovery

techniques to the reservoir. For this reason, the Board promotes the systematic gathering and documenting of all basic production and reservoir data required to evaluate the natural recovery mechanisms. Using this information, the Board often makes its own feasibility studies in oil pools to determine the merits of applying certain enhanced recovery techniques. Where it is indicated by such studies it requires an operator to conduct detailed studies which may lead to implementation of an enhanced recovery scheme. Also certain Board policies such as flexible well spacing and the crude oil production proration plan have been conceived of with the objective of encouraging optimum enhanced recovery operations. These policies have provided an atmosphere in which the industry has been aggressive and imaginative in developing efficient enhanced recovery techniques for application in a majority of crude oil pools in Alberta.

Recovery of crude oil may be substantially increased by injecting a displacing fluid such as gas, water or solvent so as to displace crude oil along the minute pore systems of the reservoir toward the producing wells in a more efficient way than would occur under the natural recovery mechanism. Where a scheme of fluid injection is proposed, approval and continued surveillance of that operation by the Board is called for. Based on information available to the end of 1970, it is estimated that conventional oil pools discovered in Alberta contained at the time of discovery about 30 billion barrels of oil in place. If these pools were each depleted by natural recovery mechanisms, the ultimate reserves obtainable would be 7 billion barrels. However, by the early implementation of enhanced recovery operations in most pools where such operations were warranted, the ultimate reserves are now expected to approach 11 billion barrels. The application of enhanced recovery methods has led to the addition of nearly 4 billion barrels to Alberta's ultimate crude oil reserves. The fact that nearly 20 billion barrels of oil in place is not yet recoverable by existing mechanisms underscores the importance of continued diligent pursuit of the development of more efficient and economic enhanced recovery processes for future use.



Additional crude oil reserves attributable to new enhanced recovery schemes plus extensions to existing enhanced recovery schemes authorized in 1970 will total about 130 million barrels when the schemes are fully implemented. The most important individual scheme approved was that proposed by an owner for an integrated scheme in the Zama Field area of northwestern Alberta involving 25 separate pinnacle reef oil pools. The owner plans to inject an enriched gas mixture into the crest of each pool to replace withdrawals of crude oil taken from lower levels of the accumulation. The enriched gas mixture and the reservoir pressure are controlled in a manner which causes the enriched gas to be miscible and act as a "solvent" for the crude oil. The result is that the crude oil will be almost completely purged from the reservoir rock pore system and it is anticipated that a very high recovery efficiency will be realized before abandonment of the last remaining oil column becomes necessary. In order for the scheme to be made economically feasible the operator found it necessary to bring a large number of relatively small pools into the scheme so that recovery and income benefits would be sufficient to pay out the relatively large capital investments and provide a satisfactory operating profit. The plan of operation involves sequential depletion of pools with enriched gas solvent being injected into about one-quarter of the pools as a first stage in a four stage plan. The solvent will spread out covering the top part of the oil pool like a blanket, and will be of a minimum size and thickness. It will then move downward displacing oil as it moves and it in

turn will be replaced by a lean gas injected above it. As first stage pools are depleted, solvent and gas will be recovered and re-used in flooding of pools scheduled for subsequent stages. By this procedure optimum use can be made of the limited supply of solvent and gas available in this area. Preparatory to designing the scheme, it was necessary to conduct detailed engineering studies to determine the technical feasibility and potential recovery benefits to be obtained from any such plan of operation. Since most of the pinnacle reefs in the Zama area are penetrated by only a single well, a great deal of geological judgment was employed in order to reasonably describe the lateral extent of each pool.

After consideration of all the evidence submitted, the Board issued a decision report in which it dealt with each aspect of the scheme including reservoir description, oil in place, solvent bank, recovery factors, production schedule, project monitoring and inter-reef communication. The scheme was approved by the Board and, when implemented, is expected to result in an increase in ultimate crude oil reserves of 31 million barrels in excess of that which would have been obtainable under primary depletion and some 18 million barrels over that predicted for gas or water flooding.

Several other pools in the Zama field were converted to bottom water injection schemes during 1970. In general, the recovery efficiency under water flood is predicted to be increased by about one-half over that expected under primary depletion. A major problem occurring in many pools in the area is early water production accompanied by rapidly declining oil production capability. The problem is particularly serious since most pools contain only one well, and if that well is abandoned, the economic life of the pool will have ended unless a replacement well is drilled. At this time the drilling of a replacement well in the Zama field does not appear economically attractive in most cases, having regard for the small reef size and the risks of faulty completion. The result is that ultimate crude oil recovery from reefs in the Zama area may depend as much upon effective well completion techniques and sound production practices as upon replacement of reservoir withdrawals.

The second largest new enhanced recovery scheme in 1970 was for a conventional water flood in the Pembina Keystone Belly River U Pool. The scheme utilizes four injection wells appropriately spaced to provide replacement of production withdrawals from 24 producing wells. The pool was expected to yield about 13 per cent recovery under natural depletion and should yield approximately 31 per cent recovery under water flood, a gain of 9 million barrels.

In the heavy crude oil category, an operator received approval for a scheme to water flood two and a half sections in the Bantry Mannville A Pool. The scheme is expected to result in improvement in recovery efficiency from 22 per cent under natural depletion to 35 per cent under water flood and should yield an ultimate crude oil reserves gain of over 4 million barrels. The scheme is being implemented to effect pressure maintenance in a part of the pool where pressures had started to decline significantly. The remainder of the pool, about 12 sections in area, enjoys substantial pressure sustenance from natural water encroachment from an adjoining aquifer and therefore will not likely require man-made water flooding.

On the negative side, the Board approved abandonment of water injection operations in a number of flood patterns in the Pembina Cardium Pool where water flood performance was very poor and the indicated oil recovery was less than that which might be expected by reverting to natural depletion. Injection operations have ceased and it is expected that continued production will restore the natural solution gas drive to an extent that will permit salvage production from unflooded sections of the reservoir. These cases are cause for concern in that water injection may have inadvertently reduced rather than increased the expected ultimate crude oil recovery. So that similar errors may be avoided in the future careful investigation will be needed to establish the reasons why the original reservoir prediction method failed to indicate premature water entry accompanied by sharply reduced production capability at producing wells.

The Board also granted abandonment of a water flood scheme in a partly depleted part of the Lloydminster Sparky Pool. While the viability of flooding this highly viscous crude oil had been viewed with some reservation, it was considered worthwhile to attempt to water flood since natural depletion from the pool was known to be very inefficient with recoveries of

only 5 to 10 per cent being obtained. Unfortunately the scheme experienced very early and adverse water breakthrough without the benefit of increased oil production and the conclusion is that water flooding will not yield recoveries significantly higher than those obtainable under natural depletion. Based on this experience, the prospect for ordinary water flooding of the relatively large deposits of crude oil in the Lloydminster area are not favourable.

CONSERVATION OF SOLUTION GAS

Oil under pressure in its natural state in the reservoir contains gas in solution and when the oil is produced much of this gas separates from the oil as the pressure is released. The gas may be used for fuel, it may be gathered and injected for storage or for pressure maintenance purposes, or it may be gathered, processed and marketed, or it may be flared. The flaring of solution gas has been recognized as a waste for many years. To ensure that solution gas is conserved wherever conservation is feasible and to retain a measure of control over conservation schemes, the Board issues Gas Conservation (GC) orders. By the end of 1970, 42 such orders had been issued.

The Board's GC orders stipulate that the licensee of each well is responsible for the conservation of any gas produced from the well within limits specified in the order. The flaring of a percentage of the raw gas produced is usually permitted, the amount being gas which experience indicates isn't economical to conserve having regard for the nature of the production and conservation system. The licensee of each well is responsible for all flaring, including any which occurs at the well, at the battery, in the gathering system and at the gas processing plant. Each GC order contains a provision whereby wells from which it is not practical to conserve the gas may be exempted from the gas gathering requirement. A number of wells on the fringes of pools where the productivity is low and for which significant equipment expenditures would be required have been exempted under this provision.

The flaring limitation prescribed for a particular field is determined following a discussion with the intended operator and from consideration of the following:

(1) Downtime due to the periodic overhaul of the gas processing plant and major system alterations which are usually carried out once a year.

(2) Downtime of facilities for normal minor maintenance other than downtime of the processing plant.

(3) Downtime due to emergency shut-down of facilities.

(4) Relationship of the capacity of the facilities to the peak gas production rates and the duration of the peak production periods.

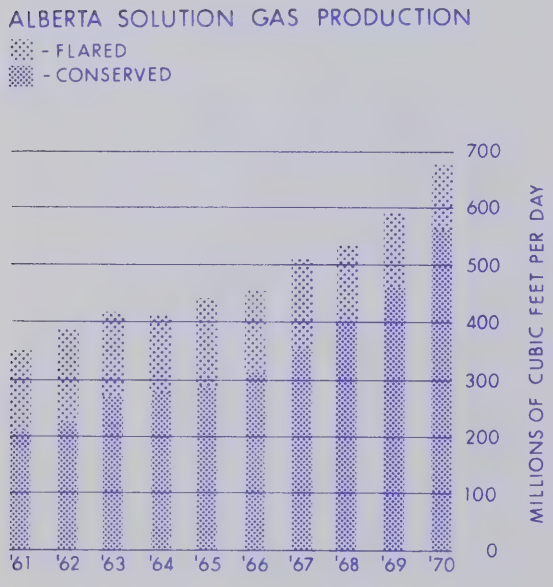
(5) The productivity of oil wells in the system.

Generally if the wells are not oil productivity limited and can be readily closed in and returned to production, the flaring limitation in the GC order is quite stringent and permits flaring of only some three to five per cent of the gas production. Conversely if it is necessary to produce the wells continuously to meet the oil allowables the flaring limitations may be more liberal.

The GC orders now issued hold the licensees of the wells responsible for any flaring. In a number of conservation schemes throughout the Province, the gathering system and gas processing facilities are owned and operated by parties other than the well owners. Although the Board generally believes a well owner should appropriately "contract" for his conservation requirements, the Board is seeking a means to provide that a third party owner or operator share some of the responsibility and be subject to appropriate penalties where it is evident that he has contributed unreasonably to gas flaring.

A number of conservation schemes not covered by GC orders are operating within the Province. Part of the Rainbow area where gas is being used to pressure maintain oil pools is in this category. In order to control flaring in such systems the Board has been issuing GC orders over the past year to cover such schemes.

As a result of the efforts of the Board and industry to improve gas conservation, some 83 per cent of the 1970 solution gas production in the Province was conserved, compared with 78 per cent in 1969, and with 60 per cent ten years ago. The accompanying chart illustrates the trend in the volume of solution gas produced and the progress made in controlling the amount of solution gas which is flared.



Over three-quarters of the solution gas conserved during 1970 was processed for sale as marketable gas, propane, butanes, pentanes plus and sulphur. The remainder was injected into underground reservoirs either for storage or to increase the recovery of crude oil. The marketed solution gas amounted to some 140 billion cubic feet, approximately nine per cent of the total Provincial marketed gas production.

The rapid growth in demand for oil during 1970 resulted in high production rates of oil and hence of solution gas. The high rates resulted in much increased flaring in fields where gas conservation is not taking place, having been considered not economically feasible at earlier lower production rates. In areas where gas is being conserved the high rates exceeded the capacity of the plant and system in many instances. A variety of interim measures were adopted to meet the conservation requirements at the increased production rates, with the most important of these being the storage of raw gas in underground reservoirs until the gas processing plant capacity could be increased.

A beneficial by-product of the conservation of solution gas is the abatement of air pollution. On this account the Board increases its efforts to bring about gas conservation in inhabited areas, even though the economics may be marginal. In assessing the economics of the conservation of solution gas containing hydrogen sulphide, the expenditures necessary for pollution control if conservation did not take place are considered. The most recent projects which have been installed to gather and process gas containing significant amounts of hydrogen sulphide are in the Erskine, Clive, Alix, Olds, Simonette, Sundre and Sturgeon Lake South fields. Efforts are currently being made to devise a scheme to reduce air pollution effects in the Joffre field, near Red Deer.

The incentives to conserve solution gas have been unfavourably influenced recently by the fact that the price of the resulting residue gas has failed to keep pace with the increase in price of unassociated residue gas. Similarly, where sulphur is a product of the processing of the raw solution gas conserved, depressed sulphur prices have unfavourably influenced the economics. Notwithstanding these effects, studies are underway into the feasibility of conserving additional solution gas in the Zama, Medicine River, Gilby and Provost fields and the Keystone area of the Pembina field.

REMOVAL OF GAS FROM ALBERTA

INTRODUCTION

The exploration activity in Alberta following the discovery in the late 1940's of oil in large quantities at Leduc and Redwater was directed mainly towards finding oil. However, in the search for oil substantial quantities of gas were also found and these gas reserves together with reserves discovered earlier provided Alberta with more gas than was immediately needed for its own requirements. Concurrently, substantial industrial expansion was in progress in Eastern Canada, Southwestern British Columbia, and parts of the United States, all of it creating strong demands for natural gas. As a result of this combination of circumstances several proposals were made in the early 1950's for moving Alberta gas to markets outside the Province.

Commencing in about 1947 the Canadian and Alberta Governments had initiated studies of the gas reserves in Alberta relative to the Province's requirements. The Alberta Government in 1948 appointed a Commission to investigate the proven and probable gas reserves and the present and future requirements of natural gas in the Province. The Commission consisted of Robert J. Dinning, Chairman, Dr. Andrew Stewart and Roy C. Marler. The Commission held hearings at major centres in the Province and subsequently submitted its report to the Government in 1949. The Commission concluded that further rapid increases in reserves would occur if there were proper incentives to explore for gas. At the same hearings, the view was expressed that the future needs of residents of the Province of Alberta should have prior claim on the gas reserves of the Province and that Canadian markets should have priority over markets outside Canada. The Commission supported these philosophies.

THE GAS RESOURCES PRESERVATION ACT

Alberta controls the removal of gas from the Province by The Gas Resources Preservation Act, enacted in 1949. The intent, purpose and object of this Act was "to effect the preservation and conservation of the oil and gas resources of the Province and to provide for their effective utilization having regard to the present and future needs of persons within the Province".

The Petroleum and Natural Gas Conservation Board, later renamed the Oil and Gas Conservation Board, was given the responsibility of administering The Gas Resources Preservation Act which included the hearing of applications, assessing the merit of each having regard to the intent of the Act, and recommending to the Government whether or not a permit to remove gas should be granted. The Act has since been amended from time to time, and while its intent and purposes remain unchanged it now regulates the removal from the Province of propane as well as gas.

EARLY APPLICATIONS FOR PERMITS TO REMOVE GAS FROM ALBERTA

Soon after the coming into effect of the Act in 1949 several applications were considered for permits to remove gas from the Province. The early applications, after being heard publicly by the Board, were denied on the basis that there were insufficient gas reserves in the Province at that time to meet the requirements of the applicants and the future needs of the Province.

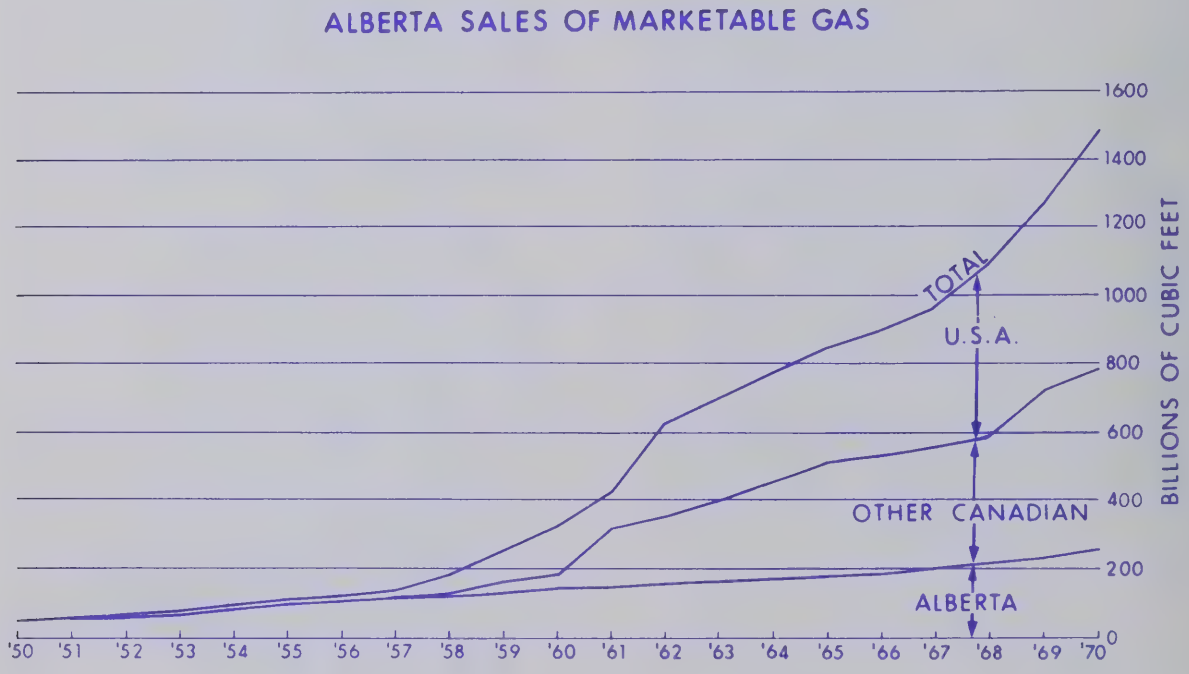
The first authorization of the removal of significant volumes of gas from the Province occurred in 1952 with the issuance of a permit to Westcoast Transmission Company Limited and Westcoast Transmission Company (Alberta) Ltd. to remove gas from the Peace River area of Alberta for delivery to British Columbia and the Northwest United States. (Minor amounts of gas had previously been authorized for removal from the Province to serve nearby areas in British Columbia and in Montana.) The permit authorized removal, subject to certain conditions, of 42 billion cubic feet during the first five years with additional quantities during the remaining 17 years of the 22-year permit period to be fixed by Board order. In October 1957 the first export from Canada of Alberta gas occurred when gas from the Peace River area was moved across the International Boundary south of Vancouver.

GROWTH IN MARKETS

Applications to remove gas to the Northwest and Eastern United States, Montana, Saskatchewan and Eastern Canada were considered at hearings during the 1950's and led to the granting of permits for major volumes of gas to Canadian-Montana Pipe Line Company, Many Islands Pipe Lines Limited, Trans-Canada Pipe Lines Limited, Westcoast Transmission Company Limited and Alberta and Southern Gas Co. Ltd. Many amendments to the major permits and many smaller permits were issued during the 1960's but no new major permittee appeared on the scene until January, 1970, when Consolidated Natural Gas Company Limited received a permit from the Board to remove gas from Alberta to the mid-west United States.

The volume of gas authorized for removal from Alberta has grown from zero in 1952 to some 37 trillion cubic feet by the end of 1970, of which some 7 trillion cubic feet had already been removed from the Province at year end. Production of marketable gas for both provincial and extraprovincial markets has grown over the same period from an annual rate of some 50 billion cubic feet to almost 1,500 billion cubic feet in 1970. This production, segmented by marketing area, is illustrated in the accompanying chart.

The chart shows that annual gas consumption within the Province has grown from about 50 billion cubic feet to over 240 billion cubic feet in the past 20 years. It also shows that the volume of gas removed from the Province has increased from a negligible quantity before production began under the first major permit in 1951, to some 22 billion cubic feet in 1957 when removal began under the major Trans-Canada and Westcoast permits, and to some 1,240 billion cubic feet by 1970. Of the latter figure some 530 billion cubic feet were utilized elsewhere in Canada and some 710 billion cubic feet were exported to the United States. The diagram on the following page illustrates the distribution in 1970 of the marketable gas produced in Alberta to the various other Canadian Provinces and to the Petroleum Administration for Defence Marketing Districts of the United States.



VOLUMES OF MARKETABLE GAS, EXCLUDING PIPELINE FUEL,
REMOVED FROM ALBERTA
TO VARIOUS CANADIAN PROVINCES AND MARKETING DISTRICTS IN THE U.S.A.-1970

ALBERTA GAS TRUNK LINE LIMITED

During the period when removal of gas from Alberta to markets outside the Province was under consideration numerous proposals were made for the gathering of gas within the Province for delivery both to local and to the extra-provincial markets. These proposals led to the establishment by the Alberta Government of Alberta Gas Trunk Line Limited as the common carrier for Alberta of essentially all gas destined for removal from the Province. Shares in the company were sold to producing companies in the Province and to interested Alberta citizens. In addition to transporting gas for removal from the Province, Trunk Line is authorized to transport gas to local markets. Where gas is transported for local use, the transportation charges are based on the volume of gas used and the distance to the nearest field from which gas might have been obtained if removal of gas from the Province was not permitted. The concept of a pipe line company acting as a common carrier of gas within the Province has worked well and application of the common carrier concept in this manner is being considered in other North American regions.

BASIS FOR CONSIDERATION OF APPLICATIONS TO REMOVE GAS FROM THE PROVINCE

The criteria which the Board applies in processing applications for permits to remove gas from the Province have developed over the years. The broad approach was formulated after the Board had heard the views of the principal users and producers at public hearings held in the early 1950's. The Board concluded that Alberta's interests would best be served both with respect to ensuring a supply of gas for its own needs and encouraging the growth of its economy, if the only gas reserves removed are those surplus to the gas requirements of the Province for a continuing or rolling 30-year period. The Government accepted this position.

The current administrative approach in assessing an application to remove gas from the Province involves the division by the Board of both reserves and requirements into a firm or contractable category and a remaining or future category. The philosophy behind this division is that there are certain requirements for which utility companies must either have gas reserves under contract or be able to negotiate for at any time. These requirements, which are taken by the Board as the current requirement level projected into the future for 30 years, plus any outstanding commitment to remove gas from the Province, are considered as the contractable requirements. These must be provided for from reserves currently available for contracting and production. These so-called contractable reserves include only proven reserves currently within the economic reach of pipe line systems and not subject to deferred production for conservation reasons. The remaining requirements which include the growth in requirements expected over the 30-year period and reserves which must be available during the 30th year to provide deliverability adequate to meet the peak day demand, may be satisfied from remaining or future reserves. The remaining reserves include reserves currently beyond economic reach, reserves from which production is currently deferred for reasons of conservation (such as the gas cap of a producing oil pool), and an allowance from reserves not yet developed. The latter is an estimated future growth which can be counted on with complete confidence on the basis of the projection of the historical growth of gas reserves and from consideration of the potential ultimate reserves of the Province.

The procedure currently followed is such that only contractable reserves surplus to the contractable requirements may be considered for removal from the Province, and then only if there is also an excess of remaining reserves over remaining requirements.

GROWTH OF ALBERTA RESERVES RELATIVE TO GROWTH OF ALBERTA REQUIREMENTS

From the supply point of view the rate of growth of Alberta's gas reserves over the last 20 years has fluctuated from year to year but generally has averaged about 2.5 trillion cubic feet per year. This rate of growth is not expected to increase significantly in the future. On the demand side the growth of the Province's own needs for gas over the past two decades, while erratic, suggests that an average growth rate of about 3.5 per cent per year can reasonably be expected in the next 30-year period. It follows that if this growth in supply remains fairly constant and eventually declines as we approach ultimate development, and if the total demand continues to grow each year, inevitably a time will come when the rate of growth of Alberta gas reserves will only be

sufficient to accommodate the growth in Alberta's own needs, and eventually not even these will be met. As to when this will occur is dependent on many factors, but primarily it will be upon the rate of growth of Alberta's own requirements, upon the ultimate reserves which will be developed in Alberta and upon the finding rate for such reserves. To an important extent it will depend upon the future price of gas relative to the price of other sources of energy. Recent studies by the Board suggest that exportable surpluses may disappear over the next 5 to 20 years, depending on the interaction of the factors discussed.

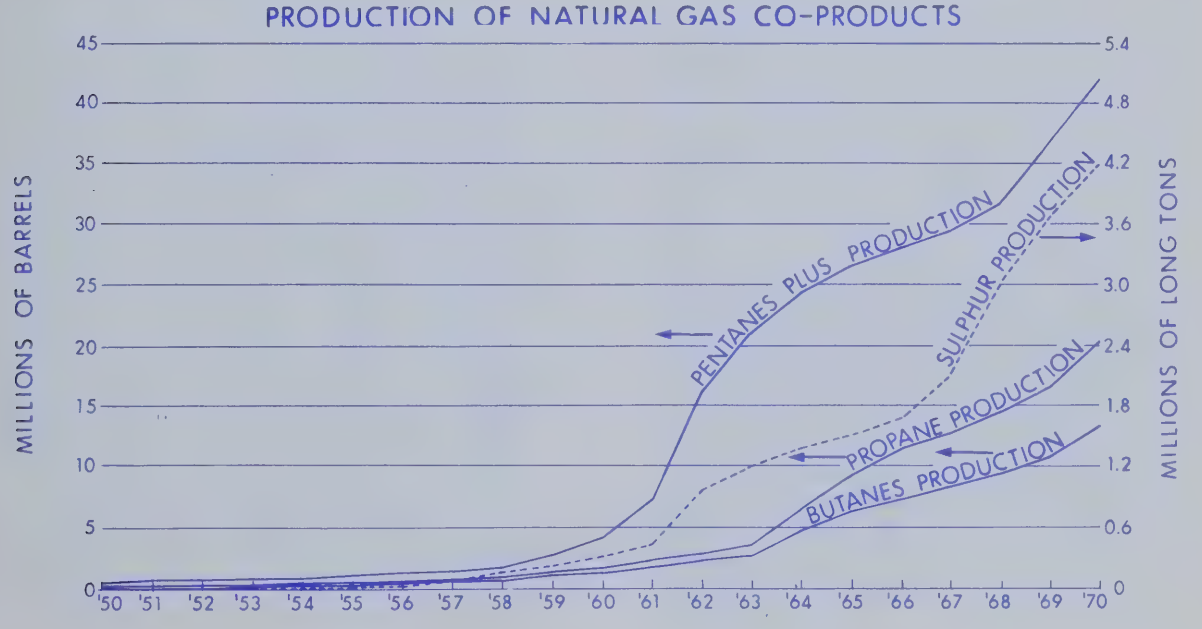
CO-PRODUCTS OF NATURAL GAS

The four-fold growth of gas production in Alberta in the past decade, primarily to supply markets outside the Province, has increased very substantially the number of plants needed for the processing of natural gas and the separation from it of natural gas liquids and sulphur. This increase has been from two or three such plants in 1950 to about 140 of them today.

Natural gas liquids are mainly propane, butanes and pentanes plus. Propane is used for space heating, carburetion and as a petrochemical feedstock; butanes are a popular raw material for refining and petrochemical industries; and pentanes plus is a product which yields a substantial amount of gasoline. Although each of these products has at times been in surplus supply during the last 20 years, they have provided a substantial amount of revenue to the Province and have improved the competitive position of many Alberta industries.

Sulphur is also being produced in ever increasing quantities in Alberta. The price of sulphur has been especially sensitive to the balance of supply and demand. In the late 1960's when demand for sulphur throughout the world exceeded supply the price rose to as much as $35.00 per ton F.O.B. Alberta and sulphur production from certain of Alberta's gas fields which contain very large percentages of hydrogen sulphide was more valuable than the marketable gas with which it was produced. Today, due to an over-supply, sulphur prices have declined to as low as $7.00 per ton F.O.B. Alberta and some gas pools containing large amounts of sulphur compounds are, for the present, not economic to develop.

The accompanying chart shows the production of natural gas liquids and sulphur by years for the period 1950 to 1970. The chart shows that annual propane production has increased from some 250 thousand barrels in 1950 to about 20 million barrels in 1970. During the same period, butanes and pentanes plus production have increased from some 30 and 460 thousand barrels per year to about 13 and 42 million barrels per year, respectively. Sulphur production has increased from a



negligibly small amount in 1950 to about 4.2 million long tons in 1970.

SUMMARY

The growth of Alberta gas production for removal to markets outside the Province has occurred under a carefully developed policy intended to serve the best interests of the people of the Province. From humble beginnings in the early 1950's gas production to markets outside Alberta has grown steadily and is now a major contributor to the Alberta economy and to Canada's balance of trade.

NEW POLLUTION CONTROL MEASURES

During 1970 the Board assumed greater responsibility for control of pollution in Alberta's oil and gas fields. The Oil and Gas Conservation Act was amended to include as one of its major purposes "the control of pollution above, at or below the surface in the drilling of wells and in operations for the production of oil, gas and crude bitumen and in other operations over which the Board has jurisdiction". To fulfil the responsibilities outlined in this amendment to the Act, the Board undertook control of pollution in a number of new areas. These included responsibility for plants processing sour gas, clean-up of oil spills from pipe lines, and clean-up and housekeeping at well sites and battery sites. To ensure that the control activities to be undertaken by the Board would run smoothly without duplication or conflict with other regulations, the Board developed with government departments a series of "Roles Documents" which described in detail the respective roles of each Government Department which had an interest in pollution control in the oil and gas industry. Roles Documents were discussed with the Department of Health, Department of Lands and Forests, Department of Mines and Minerals, the Department of Agriculture and the Research Council of Alberta. The resulting division of responsibilities is shown in the tabulation below.

Oil and Gas Conservation Board –
responsible for control of surface and subsurface pollution resulting from all oil field operations related to drilling, producing, gas processing, oil sands processing, oil spills from pipe lines, water injection supply wells and land surface clean-up.

Department of Health –
responsible for developing standards for air and water quality applicable to oil industry, monitoring air and water quality in the vicinity of oil field operations, control of disposal of oil sands or gas plant process water to lakes or streams.

Surface Reclamation Council –
responsible for final clean-up of well and battery sites in surveyed areas (except in Forest Reserves).

Department of Lands and Forests –
responsible for advising the Board regarding pollution and pollution control in forest areas, and surface reclamation on leases in forested areas (after termination of surface lease).

Department of Mines and Minerals (Pipe Line Division) –
responsible for approval and testing of pipe lines.

Department of Agriculture Water Resources Division –
responsible for conservation and regulation of surface and groundwater resources but the Board regulates the drilling of wells to obtain water for oil field purposes.

The Board's current regulations regarding pollution were expanded considerably to include the new responsibilities. To provide for increased surveillance and strict enforcement of its pollution control regulations a total of 20 new personnel was added to the Board's office and field staff, and more vehicles and pollution monitoring equipment were also acquired. Both new and continuing members of the Board staff were given courses in pollution control in oil and gas production and gas plant operation. Sampling of gas plant stack emission was covered in a special course in preparation for taking over some of the work formerly carried out by the Environmental Health Division of the Department of Health.

The new regulations enacted during the year apply to drilling, well completion, battery construction and operation, and location, construction and operation of gas processing plants.

DRILLING

To reduce the possibility of pollution from drilling operations, the Board gave special attention to the problem of disposal of the drilling fluid used during the drilling of the well. This material contains silt, rock cuttings and chemicals which can be harmful to soil or fresh water. The Board analyzed a large number of samples of drilling fluid from pits at drilling wells to ensure that disposal of clear water separated from the silt and rock cuttings would not be harmful to fresh water or soil. In addition, the Board encouraged disposal of drilling fluid into deep, porous formations where it would have no harmful effect on fresh water or oil and gas production. In a number of cases the Board prohibited the digging of pits, required the operator to use steel tanks to contain all of the drilling fluid used at the well and upon completion of the well, and to dispose of the drilling fluid at locations where it would not contaminate water or soil.

The specification for positioning the uppermost cement plug in a well abandonment program was changed to ensure that subsurface potable water down to a depth of at least 600 feet was sealed off from any possible invasion by fluids from deeper in the well.

WELL COMPLETIONS

To ensure that there is virtually no possibility of a catastrophic blow-out from a well producing sour gas, the regulations now require installation of automatic valves both on the well head and in the well bore of high volume wells where the hydrogen sulphide concentration exceeds five per cent. These valves will automatically close off the flow from the well in the case of a break in the well head or in the pipe line leading from the well, preventing release to the atmosphere of large volumes of sour gas. Another regulation dealing with wells used for injection of nonpotable water requires that the space between the tubing and the casing of the well be tested annually to ensure that there are no leaks in the tubing which might result in the salty (usually), non-potable water from the oil or gas bearing strata corroding the outer casing. Since the outer casing is the last line of defence against leaks to the outside of the well, the Board seeks to ensure there is no possibility of corrosion causing a leak in this outer string. During the year the Board also initiated the requirement that wells drilled to a depth greater than 12,000 feet must be equipped with intermediate length casing cemented in the hole to protect the well during drilling to the lower zones where high pressure gas may be encountered.

BATTERY CONSTRUCTION AND OPERATION

A regulation which prohibits the emission of smoke from burning oil or oily waste was initiated in July. This regulation has resulted in a major reduction in the number of black smoke plumes visible above oil fields. Oil producers found that most of the oil which formerly was being burned could be recovered and sold. They are now developing methods of incinerating the small remaining amounts of unsalvageable oil without creating smoke.

Operators are now required to obtain approval for the location and construction of batteries which process sour oil. This approval will be granted only when the Board is satisfied that the location of the battery is the best possible from a pollution protection point of view and that all required pollution control equipment has been included in the battery design.

The province-wide limit for disposal of water to surface pits was reduced during the year from 600 barrels to 100 barrels of water per month. Since there are many subsurface injection systems available for use by well owners, the Board felt it was time that this reduction took place in order to further reduce the risk of contamination of surface or subsurface fresh waters.

The regulation regarding the reporting of oil spills was broadened during the year to require oil producers to report any oil spill of more than ten barrels which ran off the well or battery site. The Board found during the year that many small spills were not being properly cleaned up and that some oil spills were causing minor but unsightly pollution. The field staff now inspect each oil spill as it is reported to ensure that clean-up is complete. Re-inspection may be necessary if the spill occurs during the wintertime when complete clean-up is not possible.

POLLUTION CONTROL AT A GAS PROCESSING PLANT

1. Separation and treating facilities at plant inlet remove water, condensate and hydrogen sulphide (H_2S) to produce clean gas for sale.

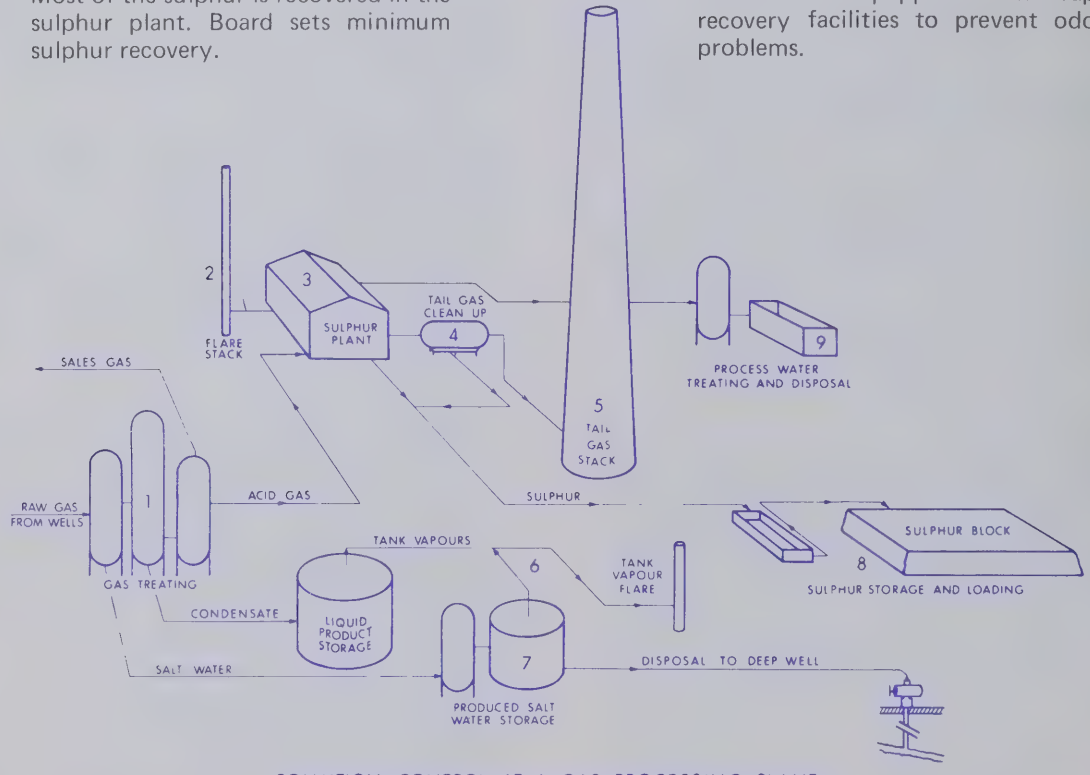
2. Flare stack handles emergencies during plant upset. Sweet fuel gas is added to sour stream while flaring to ensure combustion of H_2S to sulphur dioxide (SO_2). Height of the flare stack is specified to ensure ground level concentrations of SO_2 are acceptable.

3. Most of the sulphur is recovered in the sulphur plant. Board sets minimum sulphur recovery.

4. This unit, soon to be employed at plants, supplements recovery of sulphur, substantially reducing amount of sulphur in tail gas.

5. Stack disperses unrecovered sulphur in tail gas (H_2S is converted to SO_2) at height to keep ground level concentrations within limits set in approval. Maximum sulphur emission is also specified by Board.

6. Tanks are equipped with vapor recovery facilities to prevent odour problems.



POLLUTION CONTROL AT A GAS PROCESSING PLANT

7. Water separated from gas stream is held in tanks and disposed of through injection wells, usually to zone of origin.

8. To reduce dust problem handling block sulphur, some plants ship liquid sulphur or stockpile "slated" sulphur.

9. Process water is treated in settling ponds prior to release or injection to deep wells. Some plants recirculate process water to reduce fresh water intake.

GAS PLANTS

Responsibility for pollution control at gas processing plants was transferred this year to the Board from the Department of Health. New regulations were implemented to improve pollution control at gas plants. Special rules were set out which require public hearings of applications for construction or expansion of plants and new requirements were established for reporting of sulphur recovery and sulphur emission. The new regulations give the Board the power to suspend plant operations for contravention of sulphur emission limits which are prescribed by the Board in approvals issued for each plant. Improved and detailed measurement and reporting requirements will provide a basis for stricter control requirements and corrective action where needed. The Board indicated during the year that it would expect, and will progressively require, higher sulphur recoveries from all plants, which may be achieved through improved efficiency of current processes and from installation of new equipment to clean up tail gas. The new regulations will also require installation of continuous monitoring equipment at the larger plants which will provide a detailed record of plant operation and of sulphur emission from the plant stack. The operation of each gas plant is continuously reviewed during the year through study of submitted reports and field inspections. Where improved sulphur recovery is considered possible operators may be directed to provide a more efficient operation thus reducing sulphur emission.

The accompanying diagram shows a simple outline of the major processes in a gas plant, the sources of pollution and describes the methods used to reduce pollution.

NOTE: See diagram on previous page.

SUMMARY

In its first part-year of overall responsibility for pollution control in the oil and gas industry the Board has completed the hiring, training and equipping of sufficient staff to ensure proper surveillance and enforcement of its pollution control regulations. The Board believes that the regulations for abatement of pollution in the industry which were drafted during the year comprise a practical set of rules which if properly followed will effectively control pollution. The Board's basic objective is to see that pollution within the industry is prevented or if it occurs that remedial and preventative measures be taken promptly. The Board hopes to ensure that through the medium of properly conceived rules and an adequate level of supervision that the industry operate with the lowest level of impact on the environment that it is feasible to obtain. The industry as a whole has accepted its responsibility to ensure the least possible impact of its operations on the environment, and the Board is confident that a schedule of improved pollution abatement can be maintained that will satisfy not only a high level of health standards but meet reasonable aesthetic criteria. In addition to these current objectives, the Board also hopes to encourage and press for maximum utilization of new technology to the end that the total amount of waste material disposed into the environment will steadily decrease.

SUMMARY OF BOARD OPERATIONS — 1970

ORGANIZATION AND STAFF

The three Board members, G. W. Govier, P. Eng., Chairman, A. F. Manyluk, P. Eng., Deputy Chairman and V. Millard, Board Member, are appointed by the Lieutenant Governor in Council.

The Chief Engineer and the Solicitor act as senior advisers to the Board. They provide technical and legal advice directly to the Board and, when appointed for the purpose, they function as Acting Board Members. The Chief Engineer also chairs an Applications Advisory Group which includes the Board Solicitor and the Managers of the Gas, Oil and Development Departments. This Group advises the Board on routine applications. In addition, the Managers of the engineering departments and other senior staff serve as examiners at public hearings. A list of all Department Managers is provided on the back page of this report.

As a result of additional responsibilities assigned to the Board with respect to coal and hydro electric, the Spring Session of the Provincial Legislature provided for the expansion of the number of Board members to five, including a Chairman, two Vice Chairmen, and two Board Members; the Oil and Gas Conservation Board was also renamed the Energy Resources Conservation Board effective June 1, 1971.

The Board has a total staff of 300, an increase of 25 over the previous year, caused chiefly by the Board's increased pollution responsibilities. Approximately 60 of the staff are Engineers or Geologists. About 200 staff members are located in the Calgary head office, with the balance assigned to the Core Storage Center in Calgary, the Chemical Laboratory in Edmonton, and the area offices in Edmonton, Red Deer, Drayton Valley, Medicine Hat and Black Diamond.

The Gas Department is primarily concerned with conservation of gas and related products, including propane, butanes, pentanes plus and sulphur and determines the reserves of gas and its co-products. The Department also is responsible for assessment and surveillance of gas cycling and processing schemes as to their suitability with respect to conservation and pollution considerations.

The Oil Department is concerned with ensuring conservation and protecting correlative rights in crude oil production operations. It is responsible for assessing enhanced recovery schemes, concurrent production schemes, crude oil reserves, maximum rate limits for oil wells, oil well spacing and technical matters related to the proration plan.

The Development Department, with its Drilling and Production and its Field Divisions, is responsible for the standards and the inspection of procedures, technology and equipment used in drilling and producing wells. In addition, the Department is responsible for enforcing the Board's Environmental Control Regulations. Engineers and Technicians in area offices inspect and report on operations in the field.

The Geology Department provides geological interpretations of oil and gas reservoirs. The Core Storage Center catalogues and retains samples of drill cuttings and cores and provides facilities for their examination by industry and the general public.

The Data Processing Department is responsible for computer programming and systems design. An IBM/360-30 computer, supplemented when necessary by off-premises computer facilities, provides a fully integrated, organization-wide data storage, retrieval and processing system.

The Accounting, Economics, Office Services and Personnel Departments complete the Board's organizational structure. They provide information and service to the oil and gas industry, and to the Board and its staff.

IMPORTANT ACTIVITIES IN 1970

Oil industry activity during 1970 remained at about the same level as the previous year. Oil and gas production increased considerably due to increased exports to the United States. Drilling activity declined slightly and the results of exploration for oil and gas were generally disappointing. Exploratory and development drilling concentrated in the plains area. The search for reefs in the general Strachan Ricinus area and development of the Milk River gas reserves highlighted the efforts in the southern half of the Province. Oil discoveries were made in the northern half of the Province in Meekwap, Boundary Lake and Shekilie River and gas was discovered in the general Belloy area.

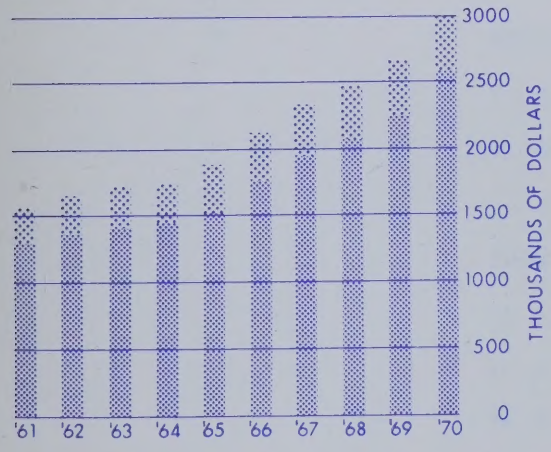
Three of five applications made to the Board requesting removal of gas from the Province were granted during the year, approving the export of some 3.8 trillion cubic feet. A thorough review was made of gas pools which appeared to be marginally economic and many small pools carried in the Board's compilation of gas reserves were deleted or reclassified as a result of the study, although the relative impact on total gas reserves was small. An application for removal from the Province of an additional 8.2 million barrels of propane was also granted.

New gas conservation schemes were installed in three fields and extensions were made to existing schemes in four fields. Gas plant

construction continued at the same strong pace as in previous years and was highlighted by the construction of a very large plant at Ram River to process gas from the Strachan and Ricinus West fields.

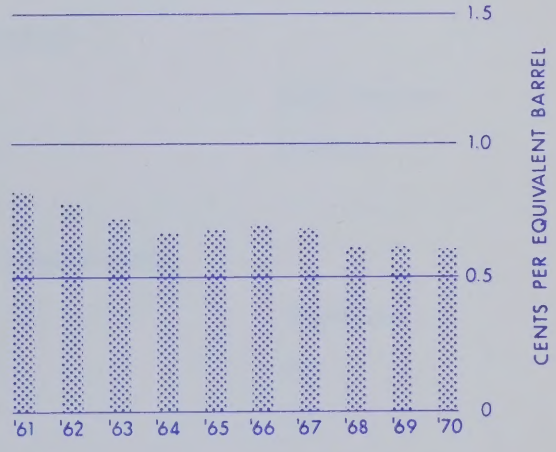
Pollution control activity received further impetus this year with the amendment of The Oil and Gas Conservation Act to give the Board further responsibility with respect to pollution control at gas processing plants and in other phases of the oil and gas industry. These changes are discussed in more detail in the article entitled "New Pollution Control Measures". Of some 140 gas plants in Alberta, there are 53 plants processing gas containing hydrogen sulphide and of the 12,000 oil and gas wells being operated some 2,300 produce sour oil or gas. The portion of the industry which produces and processes sour oil and gas is the source of the major pollution problems which occupy the Board.

BOARD NET EXPENDITURES



Much of the Board's oil and gas reservoir engineering work was focused on improving interpretation of reserves for existing pools since no major discoveries were made during the year. Applications for allowables for new oil wells dropped to less than half that recorded in 1969. A few applications for in-fill drilling of currently developed oil pools were made by operators who wished to increase the productive capacity of pools where growing demand has caused allowables to exceed the capability of the present wells in the pool. Although activity in oil sands development and experimental schemes was relatively low in 1970, renewed interest appeared to be developing at year-end. The Great Canadian Oil Sands operation, although not yet producing its target level of 45,000 barrels per day, enjoyed a significant improvement in performance and averaged some 36,000 barrels per day in 1970 compared to 27,000 barrels per day for 1969. The most significant new enhanced recovery scheme approved by the Board in 1970 was the integrated scheme for solvent flooding 25 pools in the Zama Virgo area, implemented by Hudson's Bay Oil and Gas Company. It is expected to provide an increase in ultimate reserves of some 31,000,000 barrels above that obtainable under primary depletion. The Board's engineering staff directed much of its attention to the Zama area, where there was high frequency of rapidly declining pool pressures. In view of the numerous single well reef pools

BOARD NET EXPENDITURE PER EQUIVALENT BARREL OF CRUDE OIL PRODUCTION



which appear to be in pressure communication and the high cost of developing individual pressure maintenance schemes, the Board tried to foster the co-ordination of enhanced recovery schemes among operators in the area.

Use of the Board's computer continued to expand during the year and it became clear that further growth and improvement in the system could not be obtained with the existing magnetic tape files. A re-evaluation of the Board's data processing procedures indicated

that an integrated data base carried on random access disc files would be more efficient and plans were initiated to implement this change.

REVENUES AND EXPENDITURES

The net expenditure of the Board increased to $3,005,000 in 1970 representing a 12.4 per cent increase over the previous year as compared to an average annual rate of 9.9 per cent during the past five years. In May, 1970, the Board assumed certain responsibilities regarding pollution and environmental control. These added responsibilities accounted for incremental costs of $126,000, or 4.3 per cent of the net expenditure. Without the additional pollution costs the percentage increase to net expenditure would have been 7.5 and the five year average 8.9.

In 1970, 50 per cent of the revenues to meet Board expenditures were obtained from the Government of the Province of Alberta and the levy of a tax on oil and gas properties in the Province provided the remainder. Prior to 1970 the Government provided a direct grant of 40 per cent and was taxed as the owner of Crown lands to meet approximately 50 per cent of the net expenditure.

The accompanying graphs show: (1) the level of Board net expenditures over the past ten years and the relationship of salary expenditure to the total expenditure after the deduction of miscellaneous revenue, and (2) the relationship of Board operations cost to industry production revenues in the Province. The latter is done by reducing Board net expenditure to the number of cents per equivalent barrel of crude oil production. During the last ten years this cost has been reduced from one cent to its present six-tenths of a cent.

AS OF DECEMBER 31, 1970

BOARD MEMBERS

G. W. Govier	Chairman
A. F. Manyluk	Deputy Chairman
Vernon Millard	Board Member

SENIOR ADVISERS

D. R. Craig	Chief Engineer
N. A. Macleod	Solicitor

DEPARTMENT MANAGERS

V. E. Bohme	Development
G. J. DeSorcy	Gas
N. A. Strom	Oil
E. J. Morin	Data Processing
J. R. Pow	Geology
K. W. Fuller	Accounting
J. Rimell	Economics
R. F. Braun	Personnel
J. G. Anderson	Office Services